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# INSECTS IN RELATION TO NATIONAL DEFENSE

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Circular 2

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## TERMITES


February 1941

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# NATIONAL DEFENSE

## Circular 2 - Termites

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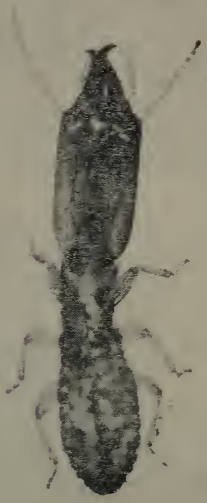
## INTRODUCTION

The prevention of damage by termites will be an important problem to be solved in connection with the construction and maintenance of the thousands of buildings used in the National Defense Program. Past experience has shown that unless special attention is given to this problem, both in the design and during the construction of buildings, these insects are almost certain to cause damage within a comparatively short time. Such damage may even occur within the first few months where optimum conditions for infestation exist and where there is a high termite population in the soil at the time construction begins. This damage can invariably be traced to certain construction details or practices which are in common use, or to carelessness and lack of knowledge regarding conditions favorable to termite infestation.

Most of the termite damage to buildings in the United States is caused by subterranean or ground-nesting termites (Reticulitermes spp.). They feed upon wood and other materials containing cellulose and are destructive pests in buildings in which wood is used. They will not normally infest buildings unless they can maintain contact with moisture in the soil, and this requirement must be kept continually in mind if control or preventive measures are to be successful.

## HOW TO RECOGNIZE TERMITES AND THEIR WORK

Termites are small soft-bodied insects about one-fourth inch long when mature. The workers (fig. 1) are about one-sixteenth inch wide, slightly less in height, and can thus crawl through cracks or very small openings. They may be easily distinguished from true ants by the fact that they do not have the strongly constricted waist-line that is characteristic of all ants. A subterranean termite colony contains three forms or castes,- workers, soldiers and reproductives. The workers and soldiers are without wings and are creamy-white in color



Figures 1 and 2 respectively. Worker and soldier termites. Enlarged about 12x.

Figures 3 and 4 respectively. Winged termite and ant. Enlarged about 4x. Note shape of bodies and size of wings.

and somewhat similar in appearance except that the soldiers have very large heads and large mandibles or jaws (fig. 2). Both of these forms lead a concealed life within their tunnels in wood and soil. The reproductives have brown or black bodies and are provided with two pairs of wings of equal size. The reproductive forms among the true ants also have two pairs of wings but these pairs are of unequal size (figs. 3 and 4).

**Figure 5. Siding removed from building to reveal hidden attack in wood.**

Large numbers of reproductive termites emerging from the soil or wood early in the spring or during the summer months may be the first indication of the presence of a termite colony. At this time they pair off and each pair attempts to find a new location for starting a new colony. When they emerge within a building they are attracted by strong light and will gather about windows or doors in an endeavor to get outside. They soon shed their wings and then try to return to the soil. Winged subterranean termites do not damage wood; only the workers do this.

Termite damage to wood is not often evident from the exterior (fig. 5). The workers avoid free

exposure to the air and therefore construct their galleries within the wood or other cellulose-containing materials which they attack. They occasionally completely honeycomb wooden timbers, leaving only a thin shell. The inside of their galleries is covered with grayish specks of excrement and earth. Subterranean termites do not reduce the wood to a powdery substance or push wood particles to the outside through openings as do certain other types of insects.

Termite infestation may also be evidenced by the presence of earth-like shelter tubes or covered runways which the termites may construct over the surfaces of foundation walls or other materials that they are unable to penetrate (fig. 6). These tubes vary in size and

**Figure 6. Shelter tubes made over impenetrable foundation wall in poorly ventilated basementless area beneath a building. In this instance infestation occurred beyond the point shown in the picture. Many tubes are being extended downward from the structurally damaged sill to the ground to contact moisture.**

shape but often are about the diameter of a pencil and are slightly flattened. They serve as covered passageways between the wood and the essential moisture in the soil, and protect the termites from the drying effect of direct exposure to the air (fig. 7).

## CONDITIONS THAT FAVOR TERMITE INFESTATION IN BUILDINGS

Subterranean termites become most numerous in moist, warm soil containing an abundant supply of food in the form of wood or other cellulose material. Such conditions are often found beneath buildings where the space below the first floor is poorly ventilated and where scraps of lumber, form boards, grading stakes or other wood are left in the soil (fig. 8). Soil within or adjacent to heated basements is kept warm throughout most of the year, even in northern areas, and results in prolonging the normal period of activity.

**Figure 7. Portion of tube shown on inner side of masonry wall within basementless foundation. Worker termites are exposed by breaking away a part of the tube.**

Probably 90 percent of all termite infestations in buildings occur because of wood being in direct or indirect contact with the ground. Such contact usually will be found at porches, steps or terraces (fig. 8). Cracks or voids in foundations also make it easy for termites to reach wood that is not in actual contact with the soil.

The species of termites that are common in the United States rarely build shelter tubes upward on exposed exterior faces of foundations to reach wood above. Underneath buildings upward tubing is uncommon on surfaces of foundations except under conditions of poor ventilation and moist soil which result in high humidity and are conducive to greater termite activity.

## PREVENTION OF INFESTATION BY TERMITES

Experience has shown that certain faulty practices in the design and construction of buildings are responsible for most of the damage caused by termites. In perhaps the majority of cases, these practices result from ignorance of, or indifference to, the danger of termite infestation. The following suggestions are made with the objective of encouraging design and construction practices which will give effective protection against infestation as well as embody good principles from the standpoint of the architect and builder.

Effective protection against infestation by termites can be assured by careful observance of the following practices in all construction work:

1. Remove all wood debris and other cellulose material from the building site.

2. Avoid all direct or hidden contacts (i.e. through voids or cracks in the foundation) between wood and soil or fill.

3. Provide adequate clearance, ventilation and soil drainage beneath all parts of the building.

4. Prevent upward tubing by termites on foundation surfaces by inspection for the removal of tubes or by the use of shields when necessary.

These broad generalizations are elaborated and defined in the following pages.

## Do Not Leave Wood in Soil

All tree roots, stumps or other wood debris should be removed from the building site before construction work is started. Form boards and all scraps of lumber should be removed before filling or backfilling after the foundation is completed. This is particularly important in the case of filled porches, terraces and steps (fig. 8 ). Spreader sticks and grading stakes should be pulled before the concrete sets. In the case of buildings without basements, scraps of lumber should not be allowed to remain on the surface of the soil beneath the buildings. If no wood is left in or on the soil the danger of a large population of termites developing in the soil and later attempting to infest the building is prevented (fig. 9 ).

## Avoid Contact Between Wood and Soil

No wood used in the building should be placed in direct contact with the soil or fill. This is very important as a means of avoiding damage by decay as well as by termites. All wooden posts, pillars, stair carriages or partitions in basements should be set on concrete footings and should never extend through or into concrete or masonry floors. Outside woodwork, such as steps, should rest on concrete footings or aprons extending at least 6 inches above grade and provided with slope for drainage (fig. 10). Lattices or skirting used to close the spaces between piers should have clearance of at least 2 inches above the soil and 1 inch from the piers (fig. 11).

Hidden or indirect contacts, through foundation walls that are not impervious or at points where porches, steps or terraces are attached to buildings, are responsible for the great majority of infestations and must be carefully guarded against (fig. 8 ).

## Clearance and Ventilation

A minimum clearance of 18 inches should be required beneath all joists, girders or other wooden parts of a building (fig.12). In the southern and more humid section of the country a minimum of 24 or 30 inches is desirable.

## FULL BASEMENT DETAILS

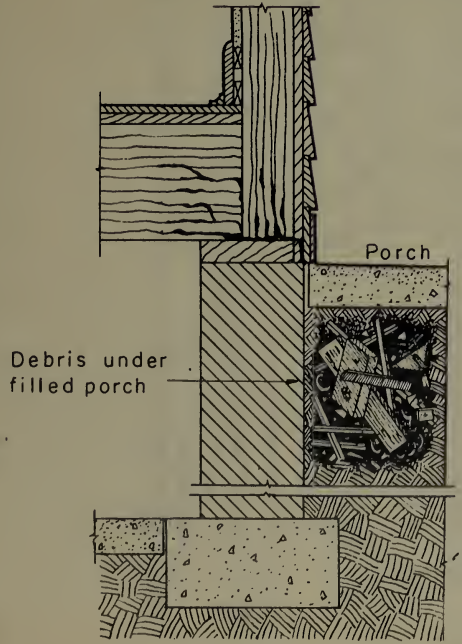



Figure 8
UNDESIRABLE BUILDING PRACTICES LEAD TO TERMITE INFESTATION

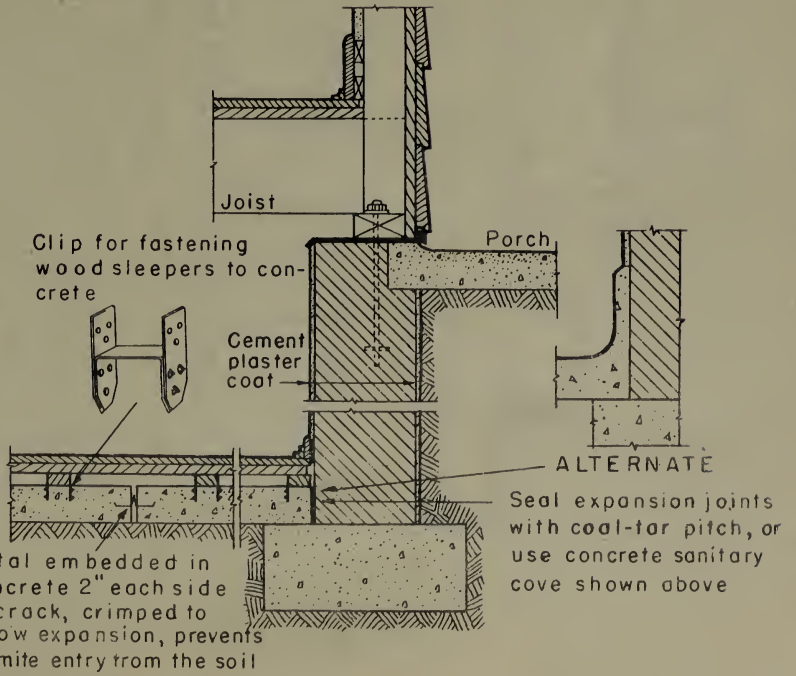



Figure 9
DESIRABLE CONSTRUCTION OR RECONSTRUCTION PRACTICES PREVENT TERMITE DAMAGE

ADAPTED FROM MCCAULEY AND FLINT

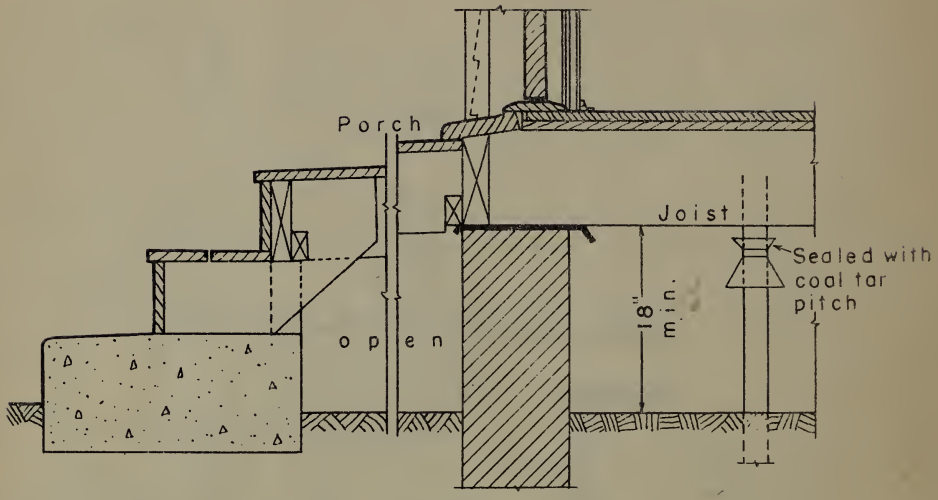



Figure 10. SIDE OF PORCH STEPS OPEN, MODIFIED BREAD-PAN SHIELD OVER WALL

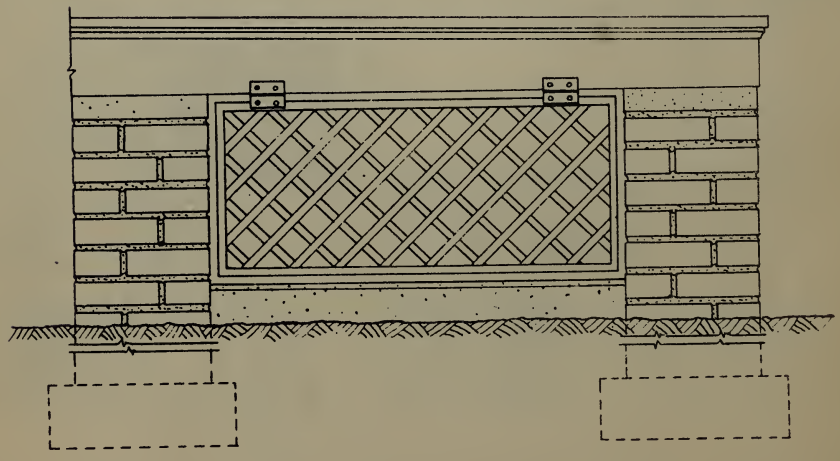


Figure 11. METHOD OF ATTACHING PORCH LATTICE TO PREVENT TERMITE DAMAGE

Ventilation space in the foundation wall should be proportioned on the basis of a minimum of 2 square feet of net opening for each 25 linear feet of exterior wall (fig. 13). The amount of ventilation required will vary considerably with the location and surrounding conditions. Some authorities recommend a minimum opening equivalent to 3 percent of the ground area occupied by the building. The openings need not be placed in the foundation on the front side of a building, provided they can be otherwise arranged to prevent any "dead ends" or unventilated areas. Shrubbery should be kept away from the openings for sufficient distance to allow free circulation of air.

Termites and decay thrive best under moist conditions. Every practical measure should therefore be taken to reduce the amount of moisture in the soil and air beneath buildings. The simplest way to attain this objective is to provide ample ventilation and clearance as specified above; the two go hand in hand, as the greater the clearance, the more readily is ventilation obtained. Clearance of less than 18 inches will not give room for making inspections for termite activity or for applying control measures in case infestations are found.

Grading and Drainage

As stated before, moisture is absolutely essential for termite activity. The outside grade should be kept at least 6 inches below all woodwork and should provide surface run-off to drain the water from the eaves or down spouts away from the building, thereby aiding in keeping the soil adjacent to the foundation as dry as possible (fig. 12). As a further aid to dryness, buildings with basements should have drainage tile around the outside of the foundation footings. Likewise, in basementless areas, every effort possible should be made to maintain dryness underneath the building.

Emphasis should be placed on the necessity of avoiding the burying of pieces of lumber or other wood material in the soil during the grading operations.

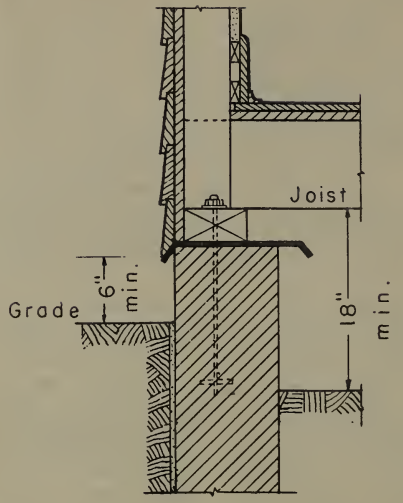



Figure 12. BREAD-PAN SHIELD OVER WALL

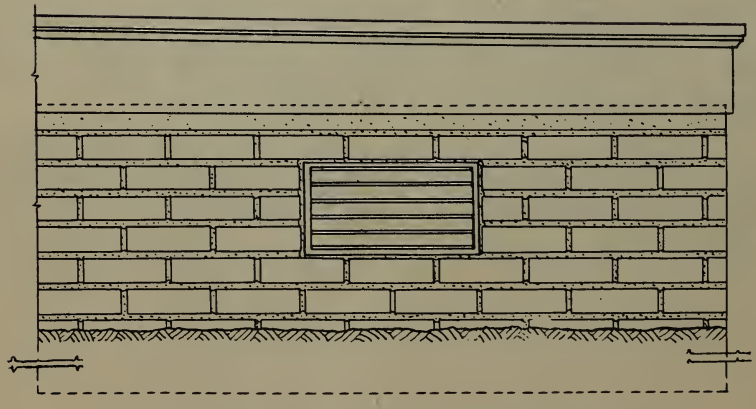


Figure 13. LOUVRED VENTILATOR
FOR BASEMENTLESS AREA

## Foundations

The use of impervious foundations is fundamental to prevention of damage by termites. Such foundations present an effective barrier to the passage of termites upward through the walls or piers from the soil to wood above. If termites are to reach wood they are forced to construct shelter tubes over the surfaces of such walls or piers. As indicated above, upward tubing is not common in most areas where proper ventilation is provided. Periodic inspection will reveal any tubes that may be constructed and they can be destroyed and control measures can be applied if necessary.

Poured concrete foundation walls or piers should be used wherever possible. All points of stress should be reinforced with steel rods to prevent cracking. Unit masonry should have the joints well filled with Portland cement mortar and should be capped with a minimum of 4 inches of plain or 2 inches of reinforced concrete, so that in case termites work their way up through or between the units they will be forced out into the open where inspection will reveal them before they reach wood above (fig.26).

Where the use of wooden piers or posts is unavoidable, as in the construction of cheap, temporary buildings, wood that has been pressure-treated with an approved preservative by a standard process, or that which is naturally resistant, should be required. (See Federal Specifications on page 16.) It is an additional safeguard to install metal termite shields on top of such piers or posts so as to prevent termites from tubing up through season checks in the posts or piers and gaining access to the building.

## Porches and Terraces

It is highly important that porches and terraces be effectively isolated from the building proper. The floor or slab of such a porch or terrace nearly always joins the exterior wall or foundation of the building at a point above the level of the sill or the joists that support the first floor. This condition usually provides termites with direct hidden access from the

soil or other fill material to the woodwork of the building and is responsible for most of the infestations in buildings of this type.

Protection against such infestation can be provided by the use of a properly designed and installed metal barrier or apron. It is immaterial whether the apron is installed over the top of the foundation wall (fig. 14) or attached to the outer side of it (fig. 15), before being extended to the top of the porch slab, just so long as the apron effectively isolates the soil and slab from the woodwork of the building and makes an impervious barrier to termite attack through hidden points of entry. An important feature that should be embodied in all such aprons is a vertical extension beneath or behind the water table or trim to serve as a flashing to prevent moisture from reaching the sill and causing decay (fig. 16 A and B).

If the apron extends over the top of the foundation beneath the sill, it should be designed so that termites will not be provided with hidden access to the sill or adjacent woodwork at either end of the apron. One method of installation is to bring the masonry or concrete up to within 2 inches of the ultimate height of the foundation. Then along the wall back of the porch lay a course of bricks with joints well filled with mortar, on which to seat the metal. At each end of the course of bricks bend the metal down to the wall, then again parallel with it, so that the outer 6 inches of the barrier can be covered with 2 inches of concrete to make the ends termite tight. Then the remainder of the wall is capped with poured concrete (figs. 17 and 18 A and B).

In situations where the porch or terrace is adjacent to a basement, the metal apron need be extended beyond the basement face of the foundation only sufficiently to allow for inspection. Where such inspections can not or will not be made, the metal should extend 2 inches horizontally and then downward for an additional 2 inches at a 45 degree angle so as to prevent termites from passing underneath and around the apron to reach the sill or other adjacent woodwork.

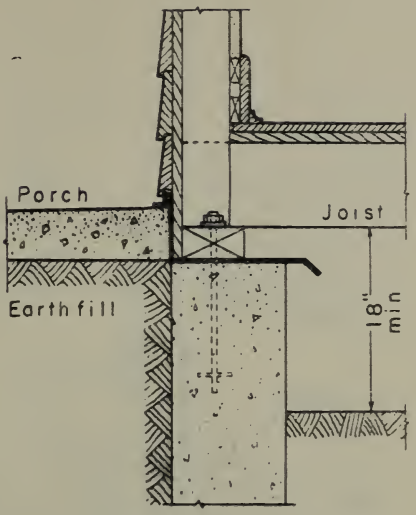



Figure 14. BREAD-PAN, OR THROUGH SHIELD OVER WALL AND PORCH

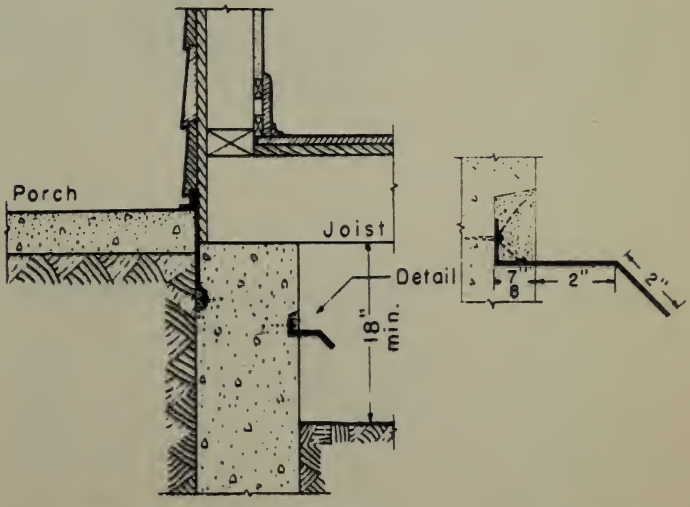



Figure 15. PATENTED SHIELD ON WALL AND PORCH

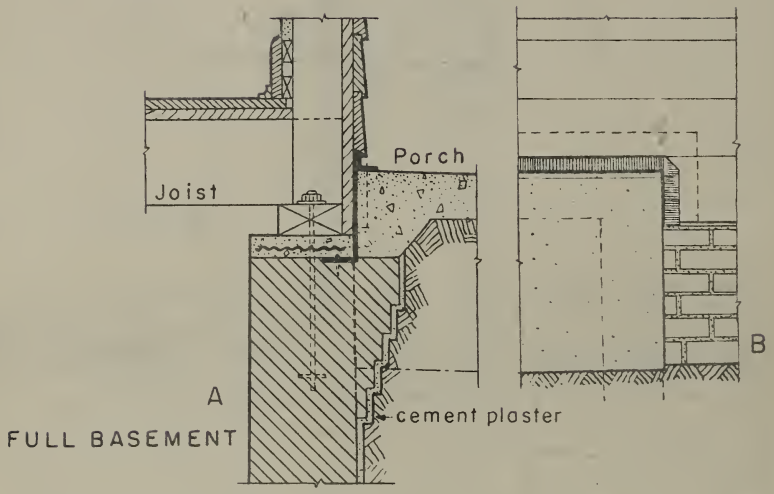



Figure 16 A - B

WALL SECTION AND FRONT VIEW OF PORCH, SHOWING USE OF STRIP TYPE METAL APRON

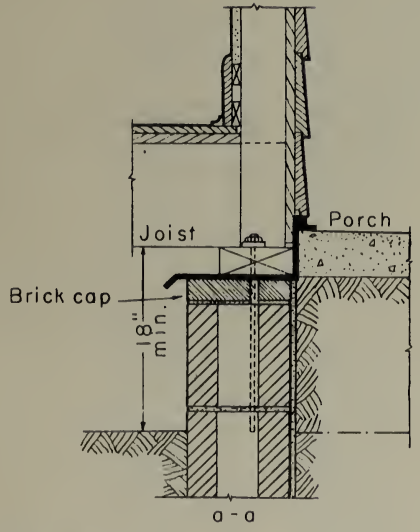



Figure 17

METAL BARRIER

OVER WALL AND PORCH

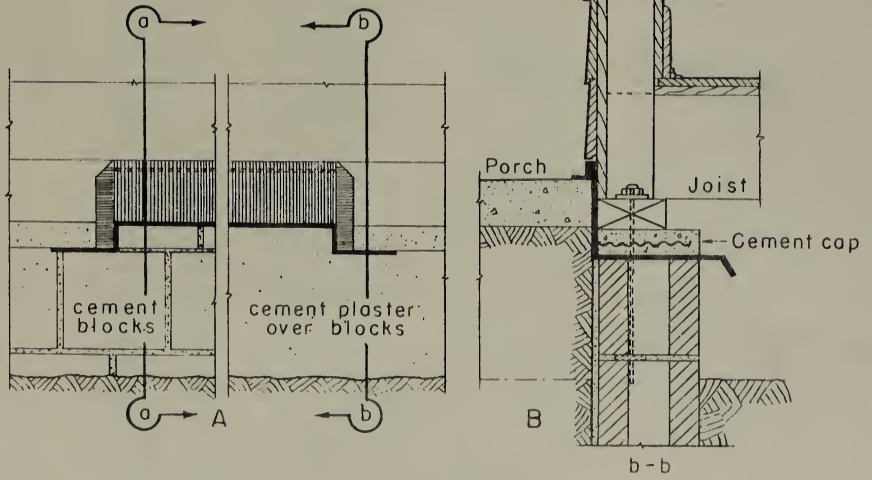



Figure 18 - A-B

FRONT VIEW OF PORCH, AND WALL SECTION

SHOWING EXTENSION OF METAL BARRIER BEYOND PORCH,

EMBEDDED IN CONCRETE

## Exterior Woodwork

### Wooden Porches or Steps

The lower or outer step and the platform supports should rest upon poured or solid concrete bases or aprons extending at least 6 inches above grade and sloped for drainage (fig. 10). If the sides of porches are to be enclosed, the siding should be supported on a low concrete wall. Provision should be made for adequate ventilation and inspections through the side walls.

### Door Frames

Door frames or jambs should not extend into or through concrete floors that rest on soil. This is particularly true for garage doors or doors leading into basements from outside stairways.

### Fuel Boxes

Outside fuel boxes should not be closer than 6 and preferably 12 inches from the building. If made of wood they should rest on concrete or masonry supports to avoid unnecessary damage by termites and decay.

### Wooden Fire Escapes

Wooden ladders attached to buildings, such as army barracks, to serve as fire escapes should rest on concrete footings or be hung with a clearance of at least 6 inches above the soil.

### Windows Below Grade

When windows or other openings below outside grade are framed with wood the foundation wall surrounding the wood frame must be impervious to termites and the level of the areaway or well bottom should be at least six inches below the lowest wood. This permits inspection

### Skirting Between Foundation Piers

Where pier foundations are used it is sometimes desirable to close the spaces between piers so as to make

it easier to heat the buildings. If this skirting is made of wood or other material containing cellulose, and is in direct contact with the earth, it may be attacked by termites as well as furnish them access to the wood above. It is, therefore, necessary to provide a minimum clearance of 2 inches between the lower edge of the skirting and the earth and 1 inch between the sides of skirting and the piers (fig. 19). If such clearance space is closed in during the winter it is very important that the space be reopened by early spring before termite activity is resumed.

Where permanent complete closing of the space between piers is required a low, poured concrete wall or beam between piers should be provided and inspected periodically for the presence of termite tubes. The skirting may then extend all the way down to this wall or beam and across the outside faces of the piers, providing it is kept at least 6 inches above grade at all points. Adequate ventilation is absolutely essential to avoid creating moist situations favorable for termites and decay. Ventilation should be proportioned on the basis of a minimum of 2 square feet of net opening for each 25 linear feet of wall (fig. 20).

Where openings for access, light or ventilation are framed with wood or other material containing cellulose, such frames should be kept above the low wall line to permit inspection. Jambs of these frames should rest upon the wall and should not be extended into or below it.

## Wood Used in Basements

### Partitions

Wood basement partitions should be placed after the concrete floor is poured. No door frames or other partition member should extend into or through the concrete floor. In large basement areas with concrete floor subject to cracking, it is important to prevent such cracking directly under the woodwork by using reinforced concrete. Metal plates or concrete plinths used under wood posts, partitions, etc., will reduce the danger of termites gaining entrance to wood through cracks in the floor and also will aid in preventing decay.

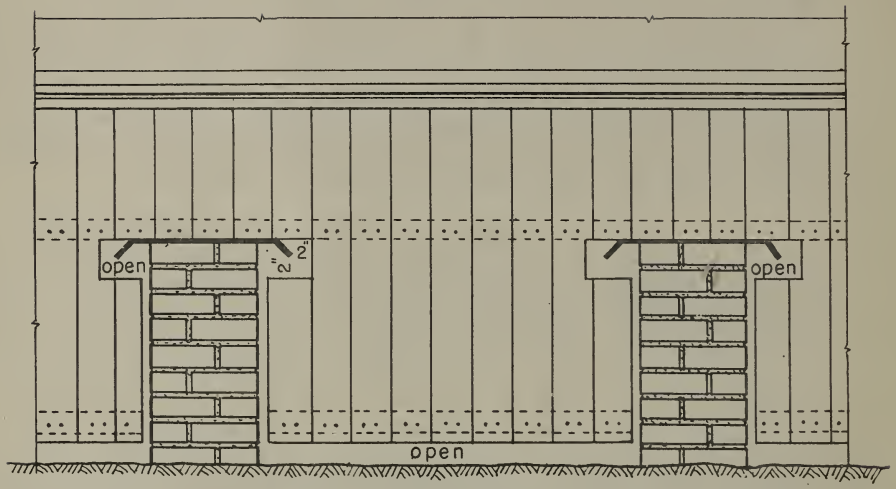



Figure 19. CLEARANCE OF SKIRTING AROUND SHIELD ON PIER, AND GROUND CLEARANCE

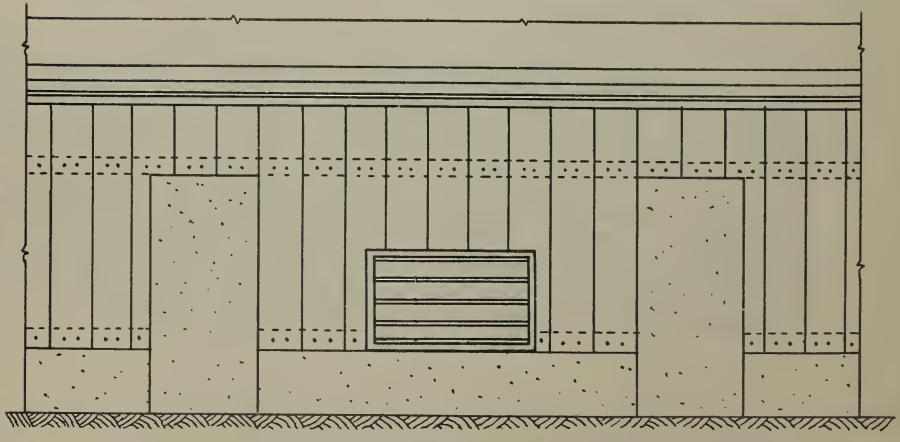


Figure 20. SKIRTING WITH VENTILATOR BETWEEN PIERS, AND RESTING ON CONCRETE CURB

Furred Walls

Where basement rooms have finished or furred wall surfaces below the outside grade level, it is advisable to use pressure-treated wood or steel furring to avoid damage by termites and decay. Termites may be provided with hidden access at form wires, spreader sticks, or cracks in the concrete wall. Expansion joints between the concrete floor and the wall should be filled with coal-tar pitch.

Wood Floors

If wood floors are to be laid over concrete, they should be protected as described on page 15.

Girders, Sills or Joists Below Grade

Avoid placing wooden girders, sills or joists in or on foundation walls below the outside grade level. Cracks, form wires or spreader sticks may provide termites with hidden access to this wood. Decay will also be a serious problem under such conditions.

Water Pipes, etc.

All plumbing, electric conduits, etc., should be clear of the ground and suspended from girders and joists. They should not be supported by wooden blocks, stakes or partitions connecting with the ground, because of the danger of termites tunneling up to the joists, sills and floors

Where concealed pipes or steel columns penetrate concrete ground slabs or foundation walls, the spaces around them should be filled with coal-tar pitch.

The use of metal shields on pipes located where soil moisture conditions are favorable for upward tubing is advisable in cases where such pipes penetrate the soil directly and cannot be inspected (fig. 10).

Concrete Platforms or Ground Slabs

Warehouses, garages, storage depots or similar structures having cement floors on grade must have no wood

used below the level of the upper surface of the floor. The top of the foundation wall should extend at least 6 inches above the surface of the floor. If the foundation is of unit masonry it should be capped with 2 inches of reinforced or 4 inches of plain concrete. Wood partitions should be placed after the floor slab has been poured and no door frames, studs, or partition member should extend into or through the concrete floor. No wood plugs should be placed in these concrete floors for nailing.

When a wooden floor is to be laid over the cement floor or slab, the sleeper joists and flooring should be pressure-treated with an approved preservative to protect against decay and termites. The expansion joints in the floor as well as the joint between the cement floor and the foundation wall should be filled either with coal-tar pitch or a crimped metal connector, or a cement sanitary cove should be used and extended up on the wall above the surface of the wood floor (fig. 9).

Cement floors that are likely to crack should be properly reinforced.

## Use of Pressure-Treated and Naturally Resistant Woods

The use of treated wood in buildings has been mentioned under the discussions of foundation piers, flooring, sleepers on concrete slabs and furring for walls. Its use is rather specialized and it is primarily intended where protection from both decay and termites is involved or where wood must come in contact with the ground or be laid on concrete on the ground. For fence posts, poles, etc., it is especially recommended. Likewise certain termite resistant woods will give good service in such positions.

### Treated Wood

The length of service to be anticipated from a given piece of chemically impregnated wood depends upon such factors as (1) the kind of preservative used, (2) the concentration, dosage and absorption, (3) the method of treatment, and (4) the conditions under which it is placed in service. In general, however, it may be said

that the longest life results from vacuum, pressure-cylinder treatments, next from hot and cold open-tank treatments, and lastly from superficial brush, dipping or spray treatments. The latter seldom add more than 2 to 5 years to the life of any timber.

The following provisions concern the use of pressure-treated wood:

> Timbers or lumber that must be used near or in contact with the ground shall be thoroughly impregnated by a standard pressure process with coal-tar creosote, with a retention of not less than 8 pounds per cubic foot of wood, or with another approved equivalent preservative,[1] to protect against damage by termites and decay. Timbers should be completely framed before treatment whenever possible, but when cutting after treatment is unavoidable, the cut surfaces shall be given two coats of hot coal-tar creosote or other equivalent preservative.
>
> Floor sleepers or joists embedded in, or laid on masonry or concrete which is in contact with the ground, shall be impregnated with an approved preservative in order to insure protection from decay and from termites that may reach the wood through cracks in the concrete or masonry.

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[1] Under present Federal Specifications TT-W-571a, the Department of Agriculture recommends impregnation with coal-tar creosote at the rate of 8 to 12 pounds per cubic foot for timbers to be used in contact with the ground; where timbers are to be used above ground and painted or finished, it recommends impregnation with zinc chloride at the rate of 3/4 to 1 pound per cubic foot.

## Naturally Resistant Wood

Where untreated wood must be used near or in contact with the ground, some protection may be had by using wood that is naturally resistant to termites. No woods are absolutely immune to termite attack, but the slow-growing heartwood of some species contains sufficient chemical extractives to make it highly resistant. Sapwood is not resistant. Among those species that are commercially available are foundation grade California redwood, all-heart southern tidewater red cypress, and "lightwood" longleaf pine.

## Use of Metal Termite Shields

To many people, termite protection simply means the installation of metal shields on the foundation of a building. This conception is erroneous, for shielding is only one means of preventing termite infestation. Where buildings are well constructed as outlined above, most of those conditions which cause termite damage are eliminated and shielding can be omitted without undue risk of attack (fig. 26).

As explained previously, upward tube building by termites is not very common on exposed surfaces of foundations except in humid enclosed areas and where the soil is moist. Consequently impervious piers or walls that are well ventilated offer adequate protection under most conditions, particularly where the soil is kept dry. Furthermore, if inspection is provided the occasional tubes which are built up on the exposed faces of concrete or masonry can be broken off and the colony treated with poison. (See pages 24 to 28) Termite protection, therefore, is mainly a matter of sound construction.

Where it is desired to use every possible means of avoiding infestation by termites or where it is impossible to comply with the foregoing recommendations as to structural requirements, it may be desirable to use shields as an additional precaution. Their use should not, however, be regarded as an excuse for accepting or allowing poor construction.

The use of shields that are properly designed and installed will result in giving as nearly complete protection as can be obtained with present known methods, providing they are used as a supplement to good construction and not as a substitute for it. Many cases have been observed where shields were installed on foundations at points where there was little danger of termites attempting to gain entrance to the building while the points of greatest danger, such as filled porches and terraces, were left unprotected. Recent experience has shown that much shielding has been poorly designed and incorrectly installed, resulting in giving the owner a false sense of security. Even when properly installed, shields give protection only during the period that the metal lasts and the joints and means of anchorage are termite tight. The importance of correct design and installation and subsequent inspections can not be over-emphasized.

In general, metal shields are recommended under the following conditions:

(1) Where unit masonry foundations are not capped with 2 inches of reinforced or 4 inches of plain concrete.

(2) Where impervious foundations are used but where moist soil conditions exist because of inadequate clearance, drainage and ventilation beneath the building (See page 8). This applies particularly to certain restricted localities where high humidity and moist soils full of organic material produce extremely hazardous termite conditions.

Several types of shields are available for use on foundation walls. The type best suited for any particular building will depend upon the nature of the foundation.

The Breadpan Type of Shield

The breadpan type of shield is especially suitable for use over masonry walls or piers of unit type (stone, tile, brick, or hollow blocks) not properly capped

with 2 inches of reinforced or 4 inches of plain concrete, to prevent termites from working through such units and reaching the foundation timbers. The following describes their proper installation:

1. On interior walls and on piers. To isolate interior walls and piers within unexcavated areas, extend the metal entirely across the top of the wall or pier beneath the sill and beyond it to project on each side 2 inches horizontally with an additional 2 inches projecting downward at a 45 degree angle.

2. On exterior foundation walls and piers. On exterior foundation walls, the horizontal projection beyond the outer face of the wall may be omitted where it is objectionable on account of appearance, as the wall is exposed and any termite activity can be readily detected. However, sufficient metal should extend beyond the wall to allow a slight projection downward to act effectively as a moisture proof flashing, and be readily inspected (fig. 12). On the interior side of these walls, full projection should be provided, the same as for interior walls and piers, when inspections are impossible or impractical. In all breadpan shielding work, the shield should be bedded on fresh cement mortar or coal-tar pitch to seal any voids made around anchor bolts where they pierce the metal barrier.

When the spaces between exterior piers are closed with skirting or lattice work a minimum clearance of 2 inches must be provided around the edge of the shield and 1 inch between the sides of the skirting and the piers (fig. 19).

The Strip Type of Shield

The strip shield is embedded in, or attached to, the side of the wall in such a manner as to form an impervious and permanent joint or union between the metal and wall. It is particularly adaptable for use on poured concrete walls (fig. 21) but may be used on properly capped unit type foundations, whether hollow or solid (fig. 22).

One type of such shield consists of a sheet of

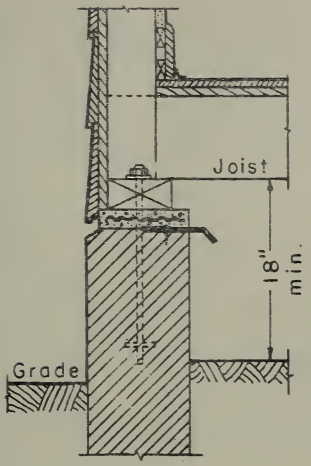


Figure 21. STRIP TYPE SHIELD OVER WALL

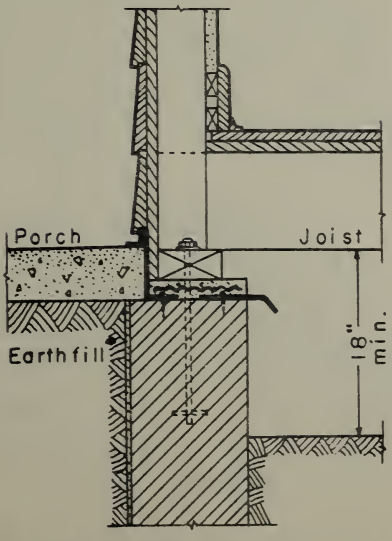


Figure 22. STRIP TYPE SHIELD AND METAL APRON OVER WALL AND PORCH

metal 8 inches wide which is embedded near the top of the foundation wall. The wall must be leveled with fresh mortar before putting the shield in place. The strip should extend over the wall for a distance of 4 inches in order that it may be properly anchored. To do this, rust-proof nails should be placed about 1 inch from the inserted edge at every 3 or 4 foot interval along the strip. The wall must then be capped with 2 inches of reinforced or 4 inches of plain concrete. This leaves exposed a horizontal projection of 2 inches with an additional 2 inches at a 45 degree angle.

Other shields of this general type have been developed by private industry; many of them are patented. Most of them are firmly inserted or attached by screws or nails to lead plugs embedded into impervious foundation walls and then further sealed by means of dense concrete or coal-tar pitch (figs. 23 and 24). Those which are designed so as to meet the same entomological requirements as fulfilled by the breadpan type of shield, as previously described, and are correctly installed in or on impervious walls, should be equally as effective.

### Additional Requirements for Installing Metal Barriers

In addition to the requirements mentioned above under each type of barrier, the following apply:

Where the barrier is made of copper, "cornice temper" hardness should be specified and it should preferably not be lighter than 16 oz. to the square foot. Where other metals are used, not less than 26 gauge should be specified. Under moist conditions ordinary galvanized iron will not last more than 5 to 10 years. Copper-bearing galvanized iron is reported to last somewhat longer.

All angles and breaks should be formed on a metal brake machine or stamped, and hand bending should not be permitted. The connections between shield lengths or widths should be locked, riveted and soldered or otherwise fastened with termite-proof joints to take up expansion and contraction stresses.

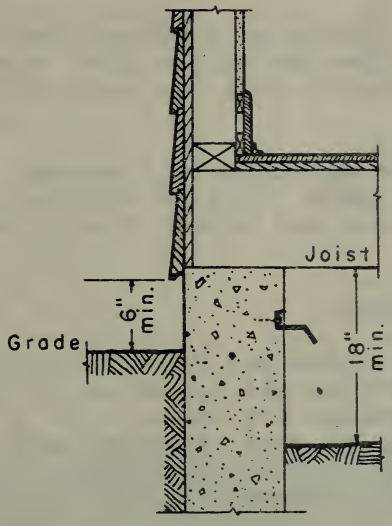


Figure 23. PATENTED SHIELD ON WALL

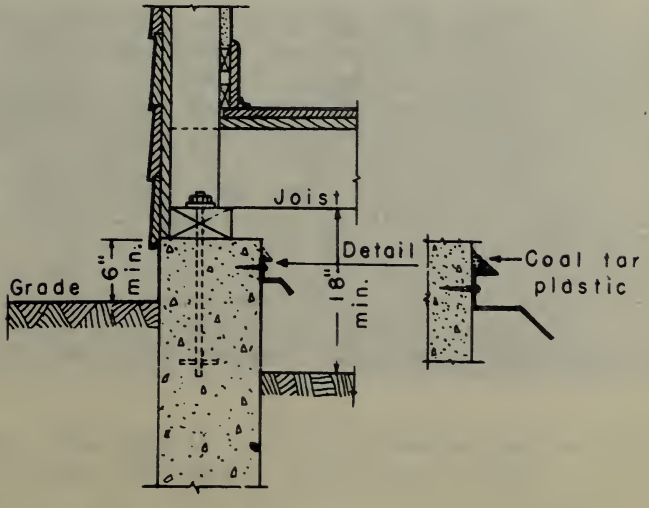


Figure 24. PATENTED SHIELD

All corners and intersections should have the metal properly joined and the projecting angles properly extended without gaps.

Steel I-beams or girders inserted in the wall below grade or below the shield line, must be boxed or otherwise protected so that the continuity of the shield is not broken.

Where shielding levels change, as at differences in outside grade lines, a vertical section or apron connecting the lower and higher shield levels should be installed.

Periodic Inspections

Periodic inspections for evidence of termite attack should be made of all buildings in sections of the country where termites are known to be a hazard. This is simply a matter of good insurance and should be insisted upon regardless of how completely preventive measures have been employed in construction. The frequency at which such inspections are needed will depend upon the abundance of termites in the area and the type of construction involved. In no instance should more than 12 months pass between inspections. If termites are found to be attacking a building, control measures as described in the following section should be employed.

## CONTROL OF INFESTATION BY TERMITES

Once a termite infestation has been discovered in the framing timbers or other parts of a building, prompt steps should be taken to control it (fig. 25). Each year the number of termites increases and the damage caused by them continues at a progressively faster rate.

In control, the same principles apply as when building to prevent infestation. That is, the passage of the workers from the moist earth to woodwork of the building must be broken. To do this all wooden parts of the building must be insulated from the ground, proper ventilation within the foundation must be provided, and wood debris must be removed from beneath and adjacent to

the building. The first important step is to locate the place of termite entry. Most frequently this will be found around the porches or through hidden points of access in the foundation. The second step is to destroy existing shelter tubes and cut off the passageway between the termites' subterranean colony and the infested units of the building. This latter step usually means cutting off their moisture supply so that those termites remaining in the wood will dry up and die. When present in large numbers, however, they will attempt to build shelter tubes down to the earth after their original passage or passages are blocked. Periodic inspections for a few days will be necessary in order to break off such new tubes to prevent their reestablishing contact with the soil moisture. A third step may be advisable in basementless areas. That is to find and destroy any wood present in the soil near walls where tubes are being constructed upward over concrete or masonry to the framing above. This should be followed by soil treatments as described below.

Figure 25. Termite tubes being extended from wood framing down to soil for establishing moisture contacts, also upward on the pier at left.

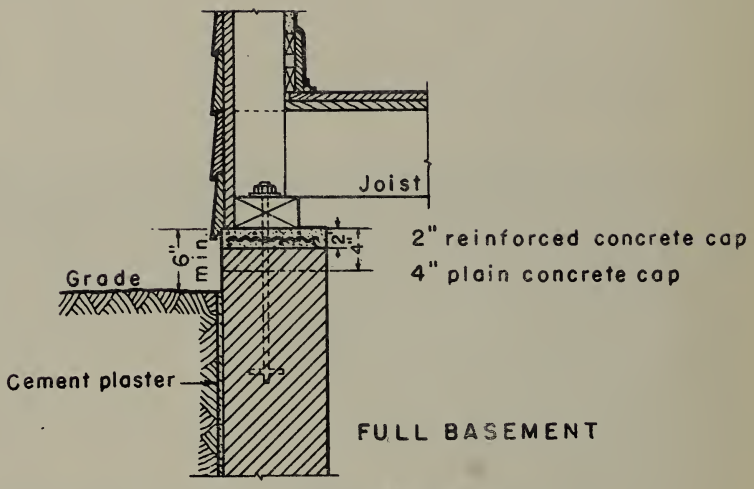


Figure 26. CAPPED MASONRY WALL

Several methods may be used to control termites, and the particular one or ones selected depends entirely upon the situation at hand. Such factors as the following must be kept in mind:

1. The value of the building.
2. The importance of the building from a use standpoint and length of service intended.
3. The money available for control work.
4. The availability of the necessary materials.

The following methods of control will be discussed and the value of each considered: - structural measures, including the use of concrete, masonry and metal barriers; soil poisons; treated wood, and termite resistant woods.

## Primary or Structural Control Methods

### Mechanical Blocking with Concrete or Masonry

The maximum and most lasting protection is obtained by mechanically blocking the termites from entering the building. Often the removal of wood from contact with the ground is sufficient. At other times voids in concrete, due to the settling and cracking of walls or expansion joints, have to be filled with a dense mortar or with coal-tar pitch. Timbers may have to be replaced, soil removed or poisoned, areas ventilated, and even metal barriers in the form of shields or aprons installed. Such changes aid in improving the building by increasing its value and in lengthening the period of serviceability. The details relative to structural changes have been discussed under the preceding section.

### Mechanical Blocking with Metal Aprons or Shields

Under conditions where buildings have not been constructed in accordance with the requirements as set forth under the preceding section and infestations have occurred, protection may be had by the use of metal barriers in the form of aprons or shields. In many instances

however, as previously mentioned, structural changes involving the use of plain concrete alone to insulate all wood from ground contacts, may be sufficient to control the termites and make the installation of metal barriers unnecessary. However, when large colonies have developed there is much more danger of upward tubing over reconstructed walls, and shields or soil poisons are additional safeguards.

Where metal aprons or shields are properly designed and correctly installed, protection will be had by the elimination of all hidden points of access. That is, where termites succeed in penetrating masonry foundation walls, they will either be checked or forced out into the open and exposed when they reach the metal guard. Careless installations result in failures and give a false sense of security. Such also represent a waste of time and money.

The installation of a metal apron or shield in an infested building requires considerably more time and expense than in the case of new construction, as frequently considerable shoring up of the building is necessary before the damaged structural members can be removed or portions of walls or piers taken down and prepared for receiving the metal barrier. In more simple cases, however, just removing a damaged sill and replacing it with sound material or concrete will allow ample room for the installation of a breadpan or strip type of guard. In still other instances, where unit type masonry (stone, brick, tile or hollow blocks) is concerned, the removal of the top layer of the foundation material may make it possible to install the metal. If taken out in 3 to 4 foot sections, jacking up the building may be unnecessary. Once the foundation or portion thereof that needs protection is prepared for the metal barrier, it should be formed and carefully installed, as mentioned under the section on shielding (pages 10 and 17 to 21).

Soil Poisons

Where it is impractical to employ structural methods alone to check termite activity, treatment with chemicals to poison the soil about walls, piers, and pipes can be used advantageously in conjunction with such methods,

or occasionally in place of them. Chemical treatments lack permanent value, however, and should not be considered as equivalent to proper structural methods. Satisfactory control in buildings cannot be expected under conditions where the chemicals are applied to or about wood that is left in contact with the ground, and decay is still possible.

Tests in the use of many chemicals as soil poisons have shown that when properly applied certain of them may be expected to give protection over a period of at least 5 years. The period of protection, however, is dependent to a large extent upon variable factors, such as the nature of the chemical or mixture, the manner of application, the texture of the soil, the level of the water table in the soil, the movement of subsurface drainage, and the exposure of the treated soil to the weather.

Some of the more promising chemicals include the arsenicals, chlorinated naphthalenes, chlorinated phenols, coal-tar creosotes, and chlorinated benzenes. They are used alone or in combination.

Most authorities agree that applications of chemicals in the form of fumigants and sprays, even when applied under pressure, are ineffective for the control of subterranean termites. Successful treatments require that the ground be saturated for a considerable depth around the foundation walls and piers of a building adjacent to possible points of termite entry. Some chemicals are poor penetrants and must be used in heavier dosages than others to be most effective.

## Precautions to Avoid Injury to Animals and Plants

The above mentioned chemicals are toxic to plant life. Where valuable shrubs or flowers are nearby (1 to 3 feet) and where it is not desirable to temporarily remove them, protection may be had by lining that side of the trench next to the shrubbery with tar paper, paraffined canvas, or copper coated kraft paper. The latter is preferable where orthodichlorobenzene is used as it has a tendency to dissolve coal-tar products. Shrubs should be kept at a sufficient distance from the wall to permit inspections

of the exterior foundation and to allow the air to circulate freely beneath the building.

Care should be taken by the workmen to avoid letting the chemicals come in contact with the body, especially the eyes. It would be advisable to use chemically resistant (rubberized fabric or Neoprene-treated) gloves and a mask in closed spaces and to provide for adequate ventilation.

In the use of these chemicals care should also be taken to prevent contamination of wells or springs by seepage.

Methods of Application

Exposed foundation. When poisons are to be applied to the soil adjacent to exterior foundation walls having deep footings, as along a full basement excavation, it is well to dig a trench the width of a shovel to a depth of 30 inches, as such a trench aids penetration of the chemical. As the earth is replaced, apply the chemical at about 6-inch intervals. It may be necessary to vary this interval, depending upon the type and moisture content of the soil and the nature of the chemical being applied and quantity used.

When the poisons are used around foundations having shallow footings, as under basementless areas, a trench only a few inches deep is sufficient.

Where a soil poison is used, such as a mixture composed of 1 part coal-tar creosote and 3 parts light fuel oil, or a 10 percent water solution of sodium arsenite, it should be applied along the exterior foundation trench at the rate of 4 gallons per each 10 linear feet (to treat approximately 25 cubic feet of soil) in the case of deep footings, and at half that rate in the case of shallow ones to treat from 10 to 12 cubic feet of soil. Treatment of the soil within foundations in basementless areas should be at the latter rate if shallow footings are present.

Where a chemical having fumigating properties is used, like orthodichlorobenzene, lighter applications

will suffice, such as 2 gallons per 10 linear feet of trench to treat deep footings and 1 gallon to treat shallow ones. Where trenching is impractical, satisfactory results may likewise be obtained in treating the soil over deep footings, by pouring this chemical into 2 inch diameter crowbar holes made 30 inches deep and spaced 15 inches apart. For this method of application, the same dosage should be used as for trenching about deep footings. In addition, it is well to saturate the entire top layer of soil to insure a continuous treatment near the surface along the foundation wall. Where walls, piers, and floors are porous, they may have to be drilled and flooded with the toxic material to treat them adequately.

Enclosed, filled or unfilled porches. The treatment of enclosed, filled or unfilled porches requires a different procedure than is used in the treatment of exposed walls. To treat and maintain an enclosed unfilled poured concrete or unit masonry porch, it is necessary to make an opening in the wall at each end so that the interior can be inspected, any form boards or other wood present can be removed, existing termite tubes can be destroyed, and the area can be permanently ventilated. In the case of masonry walls, if there is a full basement opposite the porch, a 30-inch trench should be dug along the exterior foundation within the enclosed space to aid the chemical to penetrate near the footing. Otherwise, as when a basementless area exists opposite the porch, a shallow trench all around the enclosure will be sufficient. In the case of poured concrete walls, a shallow trench is ample regardless of the basement construction, unless a crevice in the concrete has developed and extends to near the footing.

To treat a dirt-filled porch or other similar area, lasting protection will be had by inserting a metal apron as described on page 10. Where a masonry foundation is concerned protection may also be obtained by making suitable openings in the sides of the porch wall and excavating the soil to the footing. Then the exterior surface of the foundation wall should be well cleaned and faced with concrete at least one inch thick. If such procedure is impractical, a poison can be applied

to the remaining soil adjacent to the foundation after the filled earth has been removed down to about 6 inches below the outside grade. In some types of construction, where the slab is not well attached to the main wall, it may be necessary to install a supporting wall or piers in order to prevent the concrete or masonry slab above from cracking.

Ground slabs of concrete or masonry. Here again the problem is somewhat similar to the filled porch, except the space between the slab and ground is lacking as the concrete or masonry frequently rests on grade level. Where it is impractical to install a metal or concrete apron, as mentioned above, then poison the earth below the slab with a suitable toxic material after all debris and tubes have been removed and destroyed. If the main foundation wall is of masonry, it may be more convenient to apply the chemical from the basement than to excavate beneath the slab from outside. In such case, the removal of 2 to 3 feet of masonry wall, parallel with and slightly below the lower inner edge of the slab, would be possible without shoring it up. Through this opening the soil could be removed along the wall to provide a tunnel for inspection purposes and to apply the chemical. If the outside concrete or masonry slab is quite long, 2 or possibly 3 such openings in the foundation may be necessary in order to treat the soil effectively. Only one of them should be opened at a time so as to avoid the possibility of weakening the structure. One such opening should be left for future inspection.

Where the wall is of poured concrete, it is usually easier to apply the soil poison from the outside than to attempt to bore through the solid wall from the basement. This would mean excavating the earth along the foundation wall from one or both sides of the slab, removing any debris present, and applying the chemical to the shallow trench. As in the case of porches, it may also be necessary to install a wall or piers to reinforce the slab above to prevent cracking.

## LIST OF COMPANIES HANDLING CHEMICALS AND PRESSURE TREATED WOOD

The accompanying list of concerns and their products is included for the information of the users of this circular, without given or inferred guarantee of the reliability of the firms or endorsement of their individual products. No attempt has been made to make the list fully complete and no discrimination is intended or implied against firms whose names or products are not listed.

### Soil Poisons

#### Orthodichlorobenzene

Capitol Chemical Company, 1050 30th Street, N. W. Washington, D. C.
Dow Chemical Company, Midland, Michigan
E. I. duPont de Nemours & Company, Inc., Wilmington, Delaware
Electro Bleaching Gas Company, 9 East 41st Street, New York City
James Good Inc., Susquehanna Ave. & Martha Street, Philadelphia, Pennsylvania
Hooker Electrochemical Company, 60 East 42nd Street, New York City
Hughes Chemical Company, 1424 Philpot Street, Baltimore, Maryland
Mallinckrodt Chemical Works, 3600 No. Second Street, St. Louis, Missouri
Marshall Chemical Company, Marshall, Virginia
Monsanto Chemical Works, 1700 So. Second Street, St. Louis, Missouri
Niagara Alkali Company, 9 East 41st Street, New York City
Oleum Chemical Company, Scranton, Pennsylvania
Solvay Sales Corp., 40 Rector Street, New York City

#### Coal-tar Creosote - (Most paint and hardware stores)

Barrett Company, 40 Rector Street, New York City
Bermuth Lembcke Company, 420 Lexington Avenue, New York City
Creosote Sales Corp., Lexington Building, Baltimore, Maryland
Koppers Company, Tar & Chemical Division, Pittsburgh, Pennsylvania

Light Fuel Oil Of Kerosene Grade

Most oil refineries and distributors

Neoprene-Treated Gloves

American Anode, Inc., 60 Cherry Street, Akron, Ohio

Pressure-Treated Wood

Celcure

Atlantic Creosoting Company, Savannah, Georgia
Keystone Wood Preserving Company, Philadelphia, Pennsylvania
Taylor-Colquitt Company, Spartanburg, South Carolina

Chromated Zinc Chloride and Zinc Chloride

Atlantic Creosoting Company, Savannah, Georgia
J. H. Baxter & Company, 333 Montgomery Street, San Francisco, California
Taylor-Colquitt Company, Spartanburg, South Carolina
West Coast Wood Preserving Company, 1118 4th Avenue, Seattle, Washington

Coal-tar Creosote

American Creosoting Company, Louisville, Kentucky
American Lumber and Treating Company, Chicago, Illinois
Plants: Elizabeth, New Jersey - Franklyn, Virginia
Gainesville, Georgia - Crossett, Arkansas
Weed, California - Wauna, Oregon
Atlantic Creosoting Company, Savannah, Georgia
Eppinger & Russel Company
Plants: Long Island City, New York - Jacksonville, Florida
Forest Products Treating Company, 824 Pittock Block, Portland, Oregon
Plants: Dales, Oregon - Laramie, Wyoming
Gulfport Creosoting Company, Gulfport, Mississippi
J. H. Baxter & Company, 333 Montgomery Street, San Francisco, California
Norfolk Creosoting Company, 90 West Street, P. O. Box 28, Norfolk, Virginia

Coal-tar Creosote (Cont'd)

Taylor-Colquitt Company, Spartanburg, South Carolina
Republic Creosoting Company, 1607 Merchants Bank Building, Indianapolis, Indiana
Plants: Indianapolis, Indiana - Mobile, Alabama
Norfolk, Virginia
West Coast Wood Preserving Company, 1118 4th Avenue, Seattle, Washington

Wolman Salts

American Lumber and Treating Company, Chicago, Illinois
Plants: Elizabeth, New Jersey - Franklyn, Virginia
Gainesville, Georgia - Crossett, Arkansas
Weed, California - Wauna, Oregon

Zinc Meta Arsenite (ZMA)

Eppinger & Russel Company
Plants: Long Island City, New York - Jacksonville, Florida
Keystone Wood Preserving Company, Philadelphia, Pennsylvania
Norfolk Creosoting Company, 90 West Street, P. O. Box 28, Norfolk, Virginia

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Kofoid, Light, etc. -- 1935 -- Termites and Termite Control. University of California Press, Berkeley, California

McCauley, W. E., and Flint, W. P. --------- 1940 -- Outwitting Termites in Illinois. Illinois Natural History Survey Circular 37, Urbana, Illinois

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